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Two desiderata may be mentioned: (1) Satisfactory tests, preferably colorimetric, which may be quickly applied, as Hillebrand has remarked about titanium. This supplied, perhaps these earths would not be so rare. I have shown the universal occurrence of titanium. (2) Spectral data from more highly purified substances, for much that is now at hand has been obtained from impure earths.

The methods of attack at present are mainly based upon the same phenomena of oxidation, reduction and saturation. The applications are different, however. As typical examples, a few may be cited as follows: Melikow has been using the hypochlorites, virtually the Lawrence Smith method; Muthmann, hydrogen dioxide and acetate solutions; Dennis is using organic acids, as did Metzger for thorium; Jefferson and Allen have applied certain organic bases for analytical purposes, while in our laboratory we have saturated the stable alkalis, fused with sodium peroxide, and reduced with such basic reducing agents as hydrazine and phenylhydrazine, and so forth.

All is not dark, for rifts in the clouds are making. Old Watt said: 'Nature has always a weak side, if we can only find it out.' Looking back and with that century of experiences we can frequently in a measure judge of the future and those things which make toward the true end.

Naturally a sequel is due this paper, and I look forward to presenting it in my vice-presidential address before Section C of the American Association at the St. Louis meeting. Some sequels are better than their predecessors; most of them, however, are not so good.

CHAS. BASKERVILLE.

UNIVERSITY OF NORTH CAROLINA.

SCIENTIFIC BOOKS.

Inorganic Chemistry, with the Elements of Physical and Theoretical Chemistry. By J. I. D. HINDS, Ph.D., Professor of Chemistry in the University of Nashville. New York, John Wiley & Son; London, Chapman & Hall, Limited. 1902. Large 8vo. Pp. viii + 566.

Chemistry by Observation, Experiment and Induction. A Laboratory Manual for Students. By J. I. D. HINDS, Ph.D., Professor of Chemistry in the University of Nashville. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 12mo. viii + 192.

Principles of Inorganic Chemistry. By HARRY C. JONES, Associate Professor of Physical Chemistry in the Johns Hopkins University. New York, The Macmillan Company; London, Macmillan & Co., Ltd. 1903. Large 8vo. Pp. xx + 521.

A Text-Book of Inorganic Chemistry. By Dr. A. F. HOLLEMAN, Professor Ordinarius in the University of Groningen, Netherlands. Rendered into English by HERMAN C. COOPER, Ph.D., Instructor in Syracuse University, with the cooperation of the author. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1902. Large 8vo. Pp. viii + 458.

While the number of smaller and introductory text-books on chemistry which have appeared in this country during the past few years is very large, it is a long time since any new work on inorganic chemistry, which aims to be even tolerably complete, has been published. That three such works should appear within a few months of each other is evidence that a need was felt in this field. This is, of course, due to the revolution, as it might well be called, which has taken place in the fundamental conceptions of inorganic chemistry, and the recognition of the fact that these must be utilized in teaching the subject. This was early seen by Ostwald, and he must be considered the pioneer of the new didactic chemistry.

It is interesting to note how the authors before us have utilized the wealth of ma-

terial placed before them by the physical chemists. One is tempted to use a piscatorial metaphor and to affirm that Hinds has nibbled at the bait, Holleman has taken a good hold on the hook, while Jones has swallowed line, sinker and all.

These books are intended for serious college work, but the question must arise as to whether they would be suited for beginners even in college classes. In some of our colleges, most of those entering have had some smattering of chemistry, and a few have had really thorough grounding in the fundamentals of the science in the secondary schools. Yet in most college classes there are those to whom the subject is new. Just now it seems to be the fad to introduce conceptions of physical chemistry into the elementary text-books, and in one recently published the student meets the theories of electrolytic dissociation and of mass action during the first few weeks of study, while descriptive chemistry is relegated to a score or two of pages at the end of the book. In spite of all that has been said to prove that chemistry will never be a true science until it can be treated on a purely mathematical basis, it still remains the writer's opinion that a knowledge of what is sometimes rather superciliously called descriptive chemistry is fundamental to the thorough acquisition of the science of chemistry. Naturally it is not necessary, in gaining a knowledge of descriptive chemistry, to found it upon theories which are false and must be unlearned at a later period; indeed, too much theory is just what is not called for in studying descriptive chemistry. But a student must have some considerable familiarity with chemical elements and compounds and with chemical reactions before he can at all realize the bearing of chemical theories.

On the other hand, college students are supposed to have a certain maturity and development of mind, which should enable them to handle a subject in a very different manner from students of secondary schools. Theoretically a purely inductive method may be the most scientific, but practically the average college student will weary of following the arguments of a well-developed course of rea-

soning three or four weeks long, and he will lose his interest. If a partially deductive method be used, if certain of the more prominent lines of the fundamental theories are sketched before him, he sees something of the import of the phenomena he is studying, much to his pleasure and his interest. This appears to be clearly recognized by the authors of the books before us.

In Professor Hinds' 'Inorganic Chemistry' this idea is apparently carried to an extreme, for the whole of the theoretical matter is presented before descriptive chemistry is touched upon, but in this respect the book is not quite so extreme as it seems at first sight, for in the preface the author advises that the book is not intended to be studied consecutively, but lessons are to be taken alternately from the two portions. He suggests a definite order, which, however, any teacher may change to suit his own ideas. In this respect the book takes on somewhat the character of an encyclopedia, where each user may formulate his own logical system for himself. A system, this, which presents some advantages, but also some drawbacks.

This book is divided into four parts: 'Introduction,' 'Physical Chemistry,' 'Theoretical Chemistry' and 'Descriptive Chemistry,' and the third part has two divisions—'Statics' and 'Dynamics.'

The Introduction is brief and contains a short outline of the atomic theory and a description of the various divisions of chemistry.

Part II. is a review of those portions of physics which have a more or less direct bearing on chemistry, with a few pages on crystallography. The chapter on 'Interaction of Solids, Liquids and Gases' is perhaps the most unsatisfactory one in the book. Osmotic pressure is not even alluded to and the treatment of solutions is very inadequate; indeed, the whole chapter might have been written fifty years ago. The chapter on 'Changes of Physical State' is more modern and more satisfactory.

Under the head of 'Statics' we have a discussion of atoms and molecules and their properties, including the classification of atoms, valence, acids, bases and salts, nomen-

clature and some pages on formula writing and structural formulæ. The division on 'Dynamics' includes the chapters 'Chemical Actions,' 'Thermochemistry' and 'Chemical Calculations.' In the first, dissociation, ionization and the law of mass action are taken up. One can not help feeling that these sections are, as it were, dragged in, rather than that they form an integral part of the subject of which the book treats. This is especially the case when one finds, in close contiguity, the following, under the caption of superior chemical attraction as a cause of reactions: 'In the following, $\text{HgCl}_2 + 2\text{KI} = \text{HgI}_2 + 2\text{KCl}$, the K leaves the I and takes the Cl from the Hg, and the Hg and I, being set free together, unite.' Altogether, these first hundred pages or so of the book give little evidence of the advances that chemistry has made in recent years. Perhaps this would appear less conspicuous if the material were scattered through the book, as the author recommends when using the book for didactic purposes.

The remainder, some four fifths, of the book is taken up with 'Descriptive Chemistry.' The treatment of this subject is much more satisfactory. It is full enough for college classes, a good sense of proportion is observed in the amount of space devoted to the different elements and compounds, errors of statement and of typography are rare, and the material is brought well down to date. A considerable number of experimental illustrations are described, which would serve well for lecture or laboratory. The general arrangement of the elements is according to the periodic system, beginning with hydrogen and the inert gases of the eighth group, and then proceeding in order from the seventh group to the first, concluding with the metals of the eighth group. This order is occasionally departed from, as in the treatment of manganese in close connection with iron, and in discussing the atmosphere and combustion immediately after the carbon group. Thulium is placed with the halogens, samarium with manganese, and gadolinium between silver and gold, but as only a few lines are given to these rare elements, little harm is done. The nomenclature of the groups, though not absolutely new, is

new enough to appear strange, for the halogens appear under the chloroids, group VI. is treated in the two divisions of the sulfoids and the chromoids, the inert gases under the heloids, etc.

For all those teachers—and they are many—who believe that the newer conceptions of physical chemistry should be reserved for students more or less advanced in general chemistry, Professor Hinds' book will be found an excellent text-book for a thorough course in inorganic chemistry.

'Chemistry by Observation, Experiment and Induction' is a laboratory manual prepared to accompany Hinds' 'Inorganic Chemistry.' The essential feature of the book is that under each experiment a series of questions is given, with spaces in which answers are to be written. The experiments are simple and well chosen. No quantitative experiments are introduced, but there is a considerable number of problems.

In both of the books the revised spelling is used.

If Dr. Hinds almost ignores in his book the newer physical chemistry, Dr. Jones goes to the opposite extreme in his 'Principles of Inorganic Chemistry,' and the book appears almost like a treatise on physical chemistry, copiously illustrated from inorganic chemistry. Yet all the essentials of inorganic descriptive chemistry are here, but viewed from the standpoint of physical chemistry. This book must be considered the most notable contribution to didactic chemistry produced by an American since the appearance of the Remsen series of text-books.

We have here a conscientious attempt to teach general chemistry purely from the standpoint of the newer chemical conceptions, and it doubtless gives us a little forecast of what will be the character of the chemical teaching of the future. The book, however, shows the dogmatic spirit which is characteristic of many of the physical chemists of to-day. Not only are the old ideas looked upon as completely overthrown, and their adherents as antiquated—this might be condoned—but the newer theories are treated as if in them the last words in chemistry have been uttered.

This tone is illustrated by a single quotation from the book before us: "The highest aim of scientific investigation is the discovery of wide-reaching relations between large numbers of facts. Such relations when sufficiently comprehensive are known as generalizations. *Beyond these we can not go*" (italics ours). A very considerable proportion of the studies of these physical chemists center around the theory of electrolytic dissociation, and this theory is invoked to explain practically all the phenomena of chemistry. Speaking of the fact that perfectly dry sodium does not react with perfectly dry sulfuric acid, Dr. Jones tells us that 'in terms of the theory of electrolytic dissociation and catalysis these facts are just what would be expected, and could have been predicted before they were discovered.' Ostwald shows that in the light of this theory all the reactions and procedures of analytical chemistry become simple and clear. On the other hand, we must remember that the theory itself applies with strictness, as far as it concerns solutions, to those solutions only which are at great dilutions, indeed in many cases to those of such dilutions as to be practically unattainable. The theory may be invoked to explain the phenomena of concentrated solutions, multitudinous reactions of organic chemistry, reactions which take place at high temperatures, and many others, but in these fields the applicability of the theory is largely a matter of conjecture. In other words, the theory of electrolytic dissociation is not the great, universal generalization we might imagine from the writings of some of its adherents. It represents a truth, but by no means the whole truth. In certain fields, as notably that of analytical chemistry, it is exceedingly useful, though even here it by no means explains everything. It does clear up many points which were formerly obscure. One can not help sometimes wondering if it is not leading chemistry fully as much back to the views of Berzelius, as carrying it forward into new fields, and whether it may not, like the dualism of the great Swede, some near day meet its Dumas. But even should this be the case, the work of the school of modern physical chemists is of

inestimable value, and will always stand as one of the greatest advances in the development of chemistry. The dualistic theory of Berzelius was, after all, never really overthrown, but lives to-day in the theory of electrolytic dissociation. The mistake of Berzelius was in believing it applicable to all chemical phenomena. The physical chemist of to-day has found a key which fits many locks hitherto inviolable, but it has not yet proved itself to be the master-key.

In the preface to his book Dr. Jones says: "The aim of this book is to add to the older generalizations those recently discovered, and to apply them to the phenomena of inorganic chemistry in such a way that they may form an integral part of the subject, and at the same time be intelligible to the student. Why should we continue to teach the chemistry of atoms to students on the ground of its being a little simpler, perhaps, than the chemistry of ions, or on any other ground, if we know that it is not in accordance with the recently discovered facts? Or why should we continue to teach purely descriptive chemistry when the science of chemistry has outgrown this stage, and many of the most important relations have been accurately formulated in terms of the simpler mathematics? * * * If a student can grasp the conception of an atom and can not add to this the idea of the atom carrying an electrical charge, his hope of ever learning anything of chemical phenomena in general is not bright. * * * Why should chemists be hampered by being compelled to describe phenomena at length when these could be formulated in a single line? The time has come when they need not be, and the earlier elementary mathematics is introduced into textbooks on chemistry, the better for chemistry and for the chemist."

While thoroughly carrying out the spirit of the preface, the book is not, perhaps, as radical as might be expected. After opening with an introduction on elements and compounds and a chapter on the great generalizations of chemistry—the laws of conservation of mass, of constant proportion, of multiple proportions, of combining weights, the atomic theory and the correlation and conservation of

energy—an exhaustive study of oxygen is taken up, introducing the subjects of combustion, thermo-chemistry, the laws of Boyle and Gay-Lussac, absolute zero, liquefaction of gases, and closing with the experimental demonstration of the statement that ‘the real difference in the properties of oxygen and ozone is due to the different amounts of intrinsic energy present in their molecules.’

The next chapter, on hydrogen and water, leads to the phase rule and electrolytic dissociation. The following chapters on determination of atomic and molecular weights contain also dissociation, the law of mass action, and the freezing and boiling point methods. Next comes an important chapter on osmotic pressure and the theory of electrolytic dissociation, written with excellent clearness. The conductivity method is here described. A chapter on chlorin brings up the conception of acids, of valence and Faraday’s law. The subject of valence, or valency as the author calls it, has evidently been a difficult one to deal with. There is clearly an effort to confine valence solely to the ions, and structural formulæ are completely tabooed throughout the book. It would be rather rash to cut loose from structural formulæ in organic chemistry, but if they represent a truth in one field, they represent a similar truth in the other. It is true that structural formulæ have been fearfully misused and abused in inorganic chemistry, but this is no reason for completely abandoning their use and confining valence to the ion alone. The author is quite consistent, but he has thrown away a useful piece of scaffolding before the walls of his building are complete.

The periodic system is the next topic, and is well treated. We can not help thinking that some of the imperfections which the author finds would disappear if Venable’s modification of the table were used. This is particularly true of the difficulty in making sodium a member of the copper, silver, gold group, and that of grouping fluorin with manganese instead of with the halogens, where it evidently belongs.

From this point on, the elements are studied in the order indicated by the periodic table. The other halogens are followed by sulfur,

under which the temperature-pressure diagram is considered, and, in connection with hydrogen sulfid, reversible reactions. After nitrogen comes a chapter on neutralization of acids and bases, and another on the atmospheric air, including the inert gases. Under carbon dioxid we find a discussion of critical temperature and the continuity of the liquid and gaseous states, as well as a brief outline of the kinetic theory of liquids. The section on the rôle of carbon in producing light is particularly good.

After completing the metalloids (the author uses this term very sparingly, and the term non-metals not at all, as far as we have noticed), the metals are taken up, beginning with those of the alkalis. The purification of sodium chlorid gives occasion for a consideration of the application of the law of mass action to ions, and the sodium halids are used to show the transition point on their solubility curves. The phase rule finds a good illustration in the dissociation of calcium carbonate. Under zinc is an extended discussion of primary batteries and solution tension. That the book does not overlook practical applications of the subject is evidenced by nearly two pages on phosphate fertilizers and their analysis, and by a clear, if brief, treatment of iron and steel manufacture. Iron also leads to a consideration of oxidation as a method of ion formation, and of chemical action at a distance. Change of color with change in electrical charge is exemplified by the iron cyanids, and the color of ions by the permanganates. Under uranium, radio-activity is taken up, and under copper, ion formation in substitution reactions. Photography is outlined under silver; gold furnishes an example of ion formation from contact of molecules and also of colloidal solutions. This last subject is more fully taken up under platinum, where the work of Bredig is noticed.

We have thus gone rather minutely over the contents of the book because it represents somewhat of a pioneer attempt to treat inorganic chemistry from the standpoint of physical chemistry, and this necessitates presenting a pretty full outline of physical chemistry

itself. The attempt is interesting and, we must admit, very successful. The only serious omission we note is that of double and complex salts. There is a brief reference to the double mercuric iodids, a paragraph on alums, some discussion of double cyanids and chloro-platinates, but no consideration of double salts from a theoretic standpoint nor any mention of Werner's hypothesis. When one considers the number, variety and importance of double salts, he can not but feel that this omission is a defect in a book of this scope.

The book will be interesting and profitable reading for every teacher of chemistry, nor should any advanced student of chemistry fail to go carefully through it. It will be particularly valuable for those teachers whose student days were before the reign of the present physical chemists. How the book will fare as a text-book remains to be proven. In the judgment of the reviewer it would make a hard task for a beginner and should only be used for students who have a considerable knowledge of descriptive chemistry. With this view, however, the author of the book evidently differs.

The book is well gotten up, the type is clear, and the proof-reading has been almost perfectly done; the illustrations, though not numerous, are mostly new and really illustrative, and the book closes with a copious index. One other commendation must not be omitted. The style of the author is excellent. It is clear, never heavy, and at times almost conversational. This makes the book easy reading. Some may object to the author's enthusiasm; we do not. We like to read of the 'beautiful investigations' of Moissan with the electric furnace, we like to hear Wöhler called the 'great' German chemist, and we appreciate a book the better whose author is not so much engrossed with theory but that he can close its pages with the words, speaking of magnesium platocyanid: 'It is questionable whether another compound of equal beauty is known in the whole field of chemistry.'

The last book before us, that of Professor Holleman, of the University of Groningen, was first published in 1898, and two years later

a German translation appeared. The English translation has the further advantage of having been completely revised by the author, so that it is practically a revised edition.

This book bears in many respects a marked resemblance to that of Dr. Jones, so much so, indeed, that it would be superfluous to give an extended review of it. The aims and the scope of the books are the same, the methods used are similar, and the order in which the different subjects are taken up does not differ materially. Holleman's book lacks wholly the dogmatic atmosphere we have noticed in that of Jones, but it also lacks the enthusiasm of the latter, although it is very readable. Holleman treats the principles of physical chemistry rather more fully than Jones, and he introduces more mathematics, though the mathematics used is always elementary. It seems as if this makes the subject matter simpler and clearer, but many may think otherwise. Holleman is also fuller in his treatment of subjects connected with practical and technical chemistry. Taken altogether, it is impossible for the reviewer to decide which book would probably prove more successful in the class room, but both will prove very helpful to a teacher.

There is not quite the same freedom from errors that is found in Jones's, and it is occasionally evident that the book was not originally written with reference to use in America. This is particularly true in some cases of metallurgical practice. The translation is exceedingly well done, and does not read like a translation, though now and then expressions creep in which reveal the fact, as well as others which are English rather than American. For example: 'it is not supplied with a steam pipe either'; 'ferric hydrate serves as a counter-irritant' (for arsenic); 'silicon trichloride is obtained as a side-product'; 'SnS falls down as a powder'; 'SnS₂ falls out as a powder'; 'it (minium) has a pretty red color'; 'soda crystals weather,' and efflorescence seems invariably to be spoken of as weathering; 'having very different properties than liquids,' and 'than' is frequently used after 'different'; 'axles of railway carriages'; 'metallic crustations'; 'it dissolves without

generating scarcely any chlorin'; titanium, zirconium and thorium are spoken of as 'uncommon' elements.

But if these are the worst criticisms that can be passed upon the book, and this is perhaps the case, it must be conceded that both author and translator have done their work in a very satisfactory manner, and we have no doubt but that Holleman, as well as Jones, will find its way into many class-rooms and will also prove to be but a pioneer of an improved type of text-book, which will revolutionize the teaching of inorganic chemistry. And for this let us be devoutly thankful.

JAS. LEWIS HOWE.

WASHINGTON AND LEE UNIVERSITY.

A Text-book of Zoology. By G. P. MUDGE. London, Edward Arnold. 1901. Pp. viii + 416.

The author of this book is lecturer on biology at the London School of Medicine for Women, and on zoology and botany at the Polytechnic Institute, Regent Street, and is also demonstrator in biology at the London Hospital Medical College. His text-book may, therefore, be presumed to be an expression of the practice of an experienced and active teacher of biology. It differs markedly in matter and arrangement from the usual zoological texts, arranged systematically, that is, according to the accepted classification of animals. In a first part are an interesting introduction called 'the scope of biology' and a brief statement of 'the characters of the great divisions of the animal kingdom,' in which Protozoa, Metazoa, Acelomata, Coelomata, Vertebrata, Invertebrata, Diploblastica and Triploblastica are defined. Then comes a second part given to a study of 'the comparative morphology of the organs of *Scyllium*, *Rana* and *Lepus*.' The organs of these three vertebrates are discussed on the plan of the comparative anatomist, the condition of each organ or system of organs being compared in the three forms. This discussion covers one hundred and sixty-seven pages, and is illustrated by fifty-two diagrammatic figures. To this part is added a chapter of twenty-two pages on the morphology of *Am-*

phioxus. A third part, of sixty-eight pages, is given to the morphology of four celomate invertebrates, viz., *Astacus*, *Periplaneta*, *Anodonta* and *Lumbricus*, the treatment being again that of the comparative anatomist. Then comes a chapter on 'the morphology of *Hydra*,' an acelomate invertebrate, and a chapter on 'the morphology of *Paramœcium* and *Amœba*.' The fourth part of the book is composed of a chapter on 'embryology' (38 pp.), one on 'the life history of the cockroach and the butterfly, and their chief structural differences' (9 pp.), one on 'karyokinesis, oogenesis and spermatogenesis, maturation and impregnation of the eggs, and parthenogenesis' (10 pp.)!—the author is seeing the limits of his permitted space; then one on 'heredity' (26 pp.), and finally one on 'variation' (15 pp.).

When one departs from the usual and presumably approved manner of make-up of zoological text-books, the real court of appeal for the final decision as to the worth of the new manner is that composed of teachers who have tested in actual class work the usefulness and practicalness of the innovation. Thus does the reviewer easily put aside the necessity of expressing an opinion about the matter. He will hazard the guess, however, that most present-day teachers of zoology will not choose a text-book of comparative anatomy under the name of a text-book of zoology for their first-year classes.

The work outlined in the book is sound and thorough, and the discussions of heredity, variation and the scope of biology are modern and interesting. The book is compact, well-made and fully indexed. V. L. KELLOGG.

Lehrbuch der Zoologie. By ALEX. GOETTE. Leipzig, Wilh. Engelmann. 1902. Pp. 504; 512 figs.

The author of this zoological text-book is professor of zoology in the University of Strassburg. The book is intended for university classes; it is of the reference or manual of classification type of text-book, not of the laboratory guide or specifically outlined course type, as is the English text-book reviewed above. After twenty-five pages of introduc-